

Affiliation of Photographic Societies.

SIX LECTURES

ON

"Photography with the Bichromate Salts."

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I.

SCIENTIFIC AND HISTORICAL PRELIMINARY.

By CAPTAIN W. DE W. ABNEY, C.B., R.E., D.C.I.

*Delivered at 12, Hanover Square, W., on Wednesday evening, April 15th, 1896.
Mr. W. Thomas, in the Chair.*

I HAVE been asked to give a scientific and historical preliminary lecture on photography with the bichromate salts. I like the first prefix a great deal better than the second, that is, the scientific aspect better than the historical. For my own part, I would much rather spend two hours in making experiments than I would spend one in turning over the pages of musty back numbers of photographic works to ascertain what is an unimpeachably correct history of the subject with which I have to deal. Of course, it is necessary to have a general idea of the historical sequence of an invention or discovery, whatever it may be; but to love history requires a particular bent of mind, and that bent of mind is not mine, and all I am going to do to-night is to tell you, as far as I can the orderly sequence in which photography with the bichromate salts was discovered. I am labouring under one very great disadvantage—I have left my notes behind me, and consequently my dates are only given from memory.

The first date that I have to mention is 1838, the year when photography with the bichromate salts was, practically speaking, discovered. In 1839, Mungo Ponton showed that paper soaked in a solution of bichromate of potash was sensitive to light, and that a brown image was formed by its action when the paper so treated was exposed beneath a map or plan. If, for instance, the paper were exposed beneath an Ordnance Survey map there would be yellow lines on a brown background. This piece of paper has been soaked in a five per cent. solution of bichromate of potash, and, after drying, exposed beneath a negative, and here you see the result; the yellow colour, which in this case forms the background, can be washed out, and there would then be an image varying between brown and white.

The next step was made by Becquerel, in France, in 1840. He found that it really was not the paper, *quâ* paper, which enabled bichromate of potash to act, but that it was the sizing of the paper which caused the reduction of the bichromate by light. In order to test that, he coated paper with starch and bichromate of potash, and then, having washed out the bichromate, he treated it with iodine, and by that means he was able to get a blue image with a brown background, showing that the starch was really decomposed by the bichromate of potash, leaving it unaltered where the light had not acted. So here we have come to the fact that it requires what is commonly called organic matter of some description to be affiliated with the bichromate of potash in order that an image may be formed.

The next name is one which ought to be dear to every Englishman, for he was the father or co-parent of Photography, namely, Fox Talbot. In 1833 he took up the question of bichromate of potash and organic matter, and used gelatine—as far as I am aware, he was the first to use gelatine in connection with this salt—and coated copper plates with it. Here we have a small copper plate which has been coated with bichromated gelatine and exposed under a portion of a negative. Now, if we wash

out the bichromate, and place it in a solution of perchloride of iron, the copper will be etched in proportion to the solubility of the gelatine, of which, by the bye, I have not spoken at present.

Now, the question comes, How was it that the etching could take place through gelatine which had been treated in that way and exposed to light? It was in this way: it was found that the gelatine which had not been acted upon by light was, as it were, porous, and allowed the solution of perchloride of iron to soak through the gelatine and arrive at the copper; and so chemical decomposition took place, and the copper was thus eaten away, and of course, depressed surfaces were formed where the light had not acted. Where the light had partially acted the eating away was not so vigorous, and where light had strongly acted the action was nil. I have seen one or two of the original plates by Fox Talbot, and they do not leave very much to be desired, and I do not see that there has been any remarkable progress in this kind of photogravure since his time, except in matters of detail. As far as this process is concerned, it remains very much as Fox Talbot left it, though of course improved by practice.

Next in order of sequence we come to another great name, this time in France.—Poitevin (1855). I think he may be said to be the father of photo-lithography. He utilised the fact that albumen when in contact with bichromate of potash became insoluble on exposure to light, whereas the part which was not acted upon by light was soluble and easily washed away. On this piece of paper I have simply a layer of albumen which has been mixed with bichromate, and which has been printed under a negative. It was prepared by floating the back of the albumenised paper upon a solution of bichromate of potash, allowing the bichromate to penetrate, but was not for a sufficient time on the albumen to dissolve it. Printing ink was spread over the surface, and when again dry, the paper was ready for development. This was effected by soaking in cold water, and washing away the albumen and the ink from those portions which had not been acted upon by light. In this process, as I have said, we have the germ of photo-lithography; the method of using albumen for lithographic transfer is used at the present day in some processes, and has a distinct advantage in the fact that the layer of albumen is so very thin that the ink is not raised up in ridges as it is in processes where soluble gelatine is washed away.

It was Poitevin who found that gelatine which had not been acted upon by light would dissolve away in hot water, whereas the part that had been acted upon would not wash away. This piece of paper has been coated with gelatine with which Indian ink has been mixed, and then treated with bichromate. When dried it was exposed under a half-tone negative.

When Poitevin began to develop his pictures he got the same result that I expect we shall get here, that is, very little; we shall probably find that most of the gelatine will flake away, although the image itself may be there. Now I would ask you to think in what condition the paper is at the present time, having been exposed in contact with a negative. It is this—that the top surface is insoluble, while the surface next the paper must be soluble; so all we can expect when we develop is that we may get a bit of the best exposed part of the image left on the paper, the rest being washed away. You will see that this is the result we get, only those parts remain on the paper which have been thoroughly exposed to light (shown). Poitevin was thus under a great difficulty in developing his pictures, and he had to use extraordinary precautions to get any half-tone image at all.

Burnet (1858) was the first, I believe, to produce an image which could be developed with any degree of satisfaction. He argued, of course, that what was required was to get the hot water (which will dissolve away the gelatine) in contact with the soluble gelatine, and evidently if you wash it away between the paper and the gelatine the upper surface must float off and no image will be obtained. So he exposed the paper through *its back*. We have here a piece of paper which has been exposed, through the back, under a negative, and it will be seen when we develop it we shall get half-tone. This piece of gelatine tissue is home made, and is coloured simply with Indian ink, so that we have not all the refinements which the Autotype Company are able to give us, and the print will probably not be very sharp. At the

present day it is by some persons considered *chic* to have everything as coarse as possible; and I daresay Burnet's process, if they only knew it, would be adopted by that particular school of artists who love to have everything blurred and grainy.

The next name that we have to mention is Fargier (1860), who felt the difficulty that existed in printing through the paper. Fargier saw what was the *crux* of the matter; and he determined that he would print on the surface of the gelatine and then get at the back of the gelatine film,—that is to say, that surface which was next the paper. This he could do by removing the paper. He exposed a piece of tissue to light under a negative, and then coated it with castor-oil collodion—collodion to which a few drops of castor-oil had been added for the purpose of toughening it—next he put the tissue face downwards on a glass plate, and placed the whole in hot water. By degrees the gelatine in contact with the paper was dissolved, and allowed the latter to be removed. He then had his film of gelatine, forming the image, resting upon the collodion and also supported temporarily upon the glass plate. After he had developed the image, it was necessary to cement it on to paper, and he had his carbon print. Here is a print that has been produced in that manner.

I do not know whether it has ever struck you what an excellent thing we have at hand in most of our photographic rooms, in the shape of spoilt celloidin films, for carbon printing. I am going to point out to you how you can adopt Burnet's plan by the use of these films. If you have a celloidin film it is very easy to expose it through the back and get an image which is, practically speaking, sharp on the gelatine surface. The film is immersed in a three per cent. solution of bichromate of potash, and when dried provides a means of obtaining a very good transparency. We have here such a film which has been exposed through its back to a negative; simply putting it into hot water, the bromide of silver is washed away with the unaltered gelatine, and that we get an image left in bromide of silver wrapped up in gelatine. Films can be used for collotype or photo-lithographic purposes in exactly the same way.

The next point is, can we do anything more with such a transparency? Yes, we can; it can be made into a silver print very readily. Soak it in water, and pour a developer on it, and you get your image in silver. This reminds me of Mr. Bolas's method of getting a reversed negative, which he did in exactly the same way, except that in his plan you do not wash away the gelatine but by this plan you do; when you do not wash away the gelatine you get a reversed negative, and when you do wash away the gelatine you get a positive. The great thing is to thoroughly wash out the bichromate, for, if left in the gelatine, the developer would be oxidised, and for no purpose. Mr. Bolas's method is a very pretty and easy way of obtaining reversed negatives, and I am rather surprised that it has not been more generally adopted; it also provides a use for spoilt plates or films.

We now come to the next advance, which was Swan's single transfer process (1864). Swan was the first, I think, to issue carbon tissue commercially. His method of treatment was a little different to that of Fargier; he transferred the film of gelatine to gelatinised paper made insoluble by chrome alum. You can quite see that if you get the gelatine image on gelatinised paper, by removing the back surface of what we may call the bichromated tissue, we have gone a step further than anyone had gone before. But the great point was that, the picture being reversed, it was necessary to re-reverse it and get it on to other paper in its proper position. Swan effected this by coating the paper or plate to which the image was first transferred with india-rubber solution. After development he put the developed image in contact with the front surface of the gelatine, allowed it to dry, dissolved off the india-rubber, and so got his print re-reversed. This is roughly speaking, Swan's process.

The next step was Johnson's process of carbon printing (1869), in which he transferred the image bodily on to a surface, such as zinc, ebonite, porcelain, waxed paper, &c. This he effected, not by pressure, which Swan used—though Swan was not obliged to use it—simply by the fact that gelatine in a certain state adheres to these surfaces. The surface used being coated with a proper vehicle to prevent the gelatine

permanently adhering to it, he was able to retransfer it to the same kind of gelatinised paper which Swan used in his first process.

This is a very brief and incomplete history of carbon printing up to a certain point, and from that point it will be taken up by Mr. Sinclair. But there is another point that we have got to deal with; and that is the fact that gelatine, when it has been acted upon by light, not only becomes insoluble, but to a large extent repels water. Supposing we have two strips side by side, one of which has been acted upon by light, and the other of which has not been so acted upon, and soak them in water, and then rub grease of some kind over them—on the surface where the light has acted, the grease will hold, and on the other part it will be repelled—the water held by the gelatine will repel it. Further it has the property, that where the light has only partially acted, the grease will only partially hold. You can see, then, that if a sheet of bichromated gelatine, which has been exposed under a half-tone negative, is immersed in water, according to the different intensities of the light which has acted, on it, the water will be more or less soaked up. From this cause where the light has strongly acted, a greasy ink will adhere strongly, and you will have a very black surface, where it has only partially acted, a smaller quantity of ink will adhere, and where the light has not acted at all, no ink will be retained. Further, if that film of gelatine is on a flat surface, and it is put in a press with a sheet of paper in contact with it, an impression of the picture in printer's ink can be obtained. This is the foundation of the collotype process, which will be treated by Mr. Debenham in a much more explicit way.

The print I show on glass is an example of the principles which underlie another process, that known as Woodburytype. You will see that the parts which are transparent are really depressions, and where you have great blackness there are not depressions, but elevations. If by any means a mould of such a surface can be taken, you will have a surface reversed as regards depressions and elevations. Woodbury pressed such a film into soft metal by heavy pressure, and so got a mould which, when filled up with liquid gelatine, was a counterpart with the print. Mr. Bolas showed that a mould could be obtained by a very much easier plan. With fusible alloy he was able by certain manipulations to get a perfect impression of the mould. I am not going into the Stannotype process, because that would take too much time, but this print formed of elevations and depressions is its foundation, as it is of Woodburytype. As far as photo-lithography is concerned, we have not got much further than the days of Poitevin.

It now remains to show you that not only is the bichromate sensitive to light, but also the common ordinary yellow chromate. The bichromate of potash, roughly speaking, is a molecule of potash combined with two molecules of chromic acid; anyhow, there is one base and two acid molecules, while in the chromate we have one base and one acid. I do not know that the chromate has been utilised very much, or at all, but I have here a transparency produced in exactly the same way as that produced by the bichromate, except that the chromate of potash was used instead of the bichromate. Transparencies such as this made with a gelatine plate can be readily converted into a silver deposit in the same way as before.

There is still one other point which I may mention it is a little personal to myself, and therefore I mention it with due diffidence, namely, a peculiarity in the action of light on bichromate of potash when in contact with gelatine, and that is, that when you take the tissue off the negative the printing action does not stop, but continues; many years ago I made experiments and found that carbon tissue, if exposed for one-fourth the proper period and kept hung up in a darkened room for fourteen hours, would on development yield a print of full intensity. At that time I was teaching photography at Chatham, and had to do a good many carbon prints for the War Office, and I found that in the winter time it was a very great saving of time to give a quarter the proper exposure and let the continuing action of light do the rest. Mr. Foxlee afterwards took the subject up, and, I believe, found the action was due to moisture in the air. I did not explain it; I had got my own idea, but there is not time to enter into the chemical theory to-night; it is useful to explain it, as a catalytic action, a term which is applied when explanations have to be vague.

For some purposes it has been said that it is absolutely necessary to get a transparency in gelatine for certain processes ; whether that is the case or not, I very much hesitate to say—I leave those who make the statement to prove it, but if it is necessary you may sometimes get your transparency too weak. Now, if you place it in a solution of permanganate of potash, you will at once get an increase of density. You will see from the specimen before you that it gives a yellow colour—what photographers usually call “non-actinic,” though why they should do so puzzles me. If you go to France and talk about actinism, you mean heat, but in England the same term is applied to light. I do not see why photographers should not say “photographic light,” and discard the word “actinic” altogether. There are no such things as “actinic” rays ; all rays of light are exactly the same, and it all depends upon what substance they fall, whether they show as light, or heat, or chemical action. The great fault at the present day is that we are so apt to take up a term irrationally, and stick to it. I protested the other day against the phrase “new photography,” as it is the old photography applied in a different way. But when once a wrong name gets attached to a phenomenon, there is no end of mischief done.

The action of the permanganate of potash is simply that the organic matter decomposes the permanganate, and oxide of manganese is thrown down on the gelatine.

Now I never feel as if any lecture is complete when dealing with light unless we introduce the spectrum. Of all beautiful things—including a beautiful face—the spectrum is the most beautiful ; it has no form, and is void of artistic properties in many ways, but the colouring is to me an endless source of enjoyment. Here is a spectrum, and you will see that if we cause the beam of white light forming it, to pass through a solution of the bichromate, that all the blue and a good deal of the green are cut off. We may expect that the light which can decompose the bichromate is that which it absorbs. Practically speaking, gelatine absorbs very little light, and we are not in a position to say that it is sensitive to light at all. According to the doctrine of energy, what is absorbed by a substance must do work in that substance, somehow or another ; and if it happens that the molecules of the body are readily decomposable, we have chemical action taking place in the substance. We know that the bichromate of potash is decomposed, and we may suppose that all those rays which are cut off will be chemically active. If we use the chromate of potash we find a rather different state of affairs, as you see now. The relative sensitiveness of the neutral salt and the bichromate is about one and a half to one.

I have now two slides to show you. The top figure on the first one shows the result obtained by coating a plate with gelatine and lampblack and exposing it through the glass to the spectrum ; and the figure below is the result obtained by immersing a bromide plate in solution of bichromate of potash and also exposing through the back. I want you to notice that there seems to be a slight difference in the length of the spectrum, it seems as if the bichromated gelatino-bromide film was a little more sensitive to the green rays than the bichromated gelatine without any admixture. The second slide shows similar experiments with the chromate. We are bound to deduce from this experiment that it is a saving of time to adopt the carbon method of printing in the winter rather than printing with silver salts, as there are then plenty of green rays, whereas the blue rays are very largely quenched. As the blue rays are principally active in forming a silver print, it follows that the sensitiveness of a bichromate paper suffers less than does a paper coated with silver chloride at the time of year when the blue rays are at a minimum.

The CHAIRMAN expressed to Captain Abney the thanks of the Sub-Committee of the affiliation delegates for his great kindness in consenting to open the course of lectures, and he proposed that the cordial thanks of the audience be also accorded to him for his most interesting discourse.

Mr. T. BOLAS seconded the motion, which was thereupon put and carried by acclamation.

Captain ABNEY, in acknowledging the vote, said he regarded it as his duty as the President of the Royal Photographic Society to accede to the wish that he should deliver the first lecture of the series, and in that way to manifest the interest felt by the parent society for the societies affiliated with it.

II.

CARBON PRINTING.

By J. A. SINCLAIR, F.R.P.S.

Friday, April 17th, 1896. The Earl of Crawford, K.T., in the Chair.

CAPTAIN ABNEY, in the course of his introductory lecture, told us that he did not love history, and forthwith proceeded to give an admirable historical review of the subject which will receive our attention this evening. He materially cleared the way for us, by demonstrating the early methods of carbon printing, but I shall hope to bring before you some of the details relating to these methods,—details, that in a comprehensive review of a great subject are necessarily ignored—but which, in view of the controversy proceeding in the photographic press between the advocates of various systems, are of very considerable interest. It being advisable that we should know something about the evolution of the processes which I intend to demonstrate, I shall venture to draw your attention again to a few of the honoured names in the early history of this beautiful method of reproduction, even at the risk of repeating what Captain Abney has said.

In the first place it is hardly necessary to say that the name “carbon printing” is not absolutely correct. The pioneers of the process used carbon, but later investigators realised that an almost unlimited range of colour was at their command by substituting other permanent pigments. The process is based upon the principle that gelatine, when sensitised with a bichromate salt, becomes insoluble under the action of light; therefore if we imprison pigment in the gelatine we shall have an image in colour in the insoluble portion remaining after the soluble parts have been washed away.

Our starting point is the year 1855, in which Poitevin patented his method of carbon printing. In 1839, Mungo Ponton observed that paper soaked in bichromate of potash was darkened by the action of light, but it was not until 1853 that Fox Talbot discovered that gelatine when sensitised with a bichromate salt, became insoluble on exposure to light. He coated metal plates with this sensitised gelatine, exposed to light under a negative, and after washing away the soluble portions etched with acid. Clearly this was the basis of our photogravure process. Two years later Poitevin made the first carbon print. His method consisted in painting paper with a mixture of vegetable carbon, bichromate of potash and gum, exposing to light, and afterwards washing away the portions not acted upon. This process, which is practically the one advocated by many leading artistic photographers to-day, was full of difficulties. Line subjects were rendered very well, but with other classes of work it was found exceedingly difficult to preserve the half-tones. This loss of half-tone was a serious drawback to a long-looked-for permanent printing process, and set other workers experimenting to improve the method of coating the paper. In 1857 Beauregard, by means of a leather pad, rubbed pigment on to the surface of bichromatised gelatine in order to get a very thin coating, and I think I shall be able to show you presently that to successfully work any method of carbon printing, without transfer, it is essential that there should be a very thin and even coating of colour on the surface of the paper. Beauregard also had another system; he immersed the paper in a bath of the pigment ground up with water and mixed with bichromatised gelatine. The next advance was made in 1858 by Pouncy, who produced his results before the Photographic Society of Great Britain, but met with very little consideration from the members, the majority of whom appear to have been enthusiastically devoted to the charms of albumen paper. In the *Photographic*

News of that period you will find very violent articles against him, and in *Sutton's Notes* there are articles just as strong in his favour. Certainly he seems to have been the first to have made a carbon print in England; if his results were crude, still they were very important, because they laid the foundation for the process which we have to-day. He brushed over and into a "slack-sized" paper—which I suppose means paper with but little sizing upon it, so that the colour might soak into the paper—a mixture consisting of a saturated solution of bichromate of potash, gum arabic solution of the consistency of varnish, and vegetable carbon ground in water. Sutton also seems to have been experimenting on the same lines, and he used blotting paper, which took up a good deal of colour, but when it was exposed and washed the colour came away from the paper where the light had not acted. In 1858, Burnet and Blair found that the half-tones could be preserved by printing through the paper; but this gave them a granularity of result which found little favour in those days, when microscopic detail was considered essential. Blair afterwards waxed the paper in order to get less grain and a more pleasing image. In the same year Poitevin coated paper with dextrin, bichromate, and sugar, exposed, and "dusted on" the image after subjecting the film to the action of steam; the pigment thus dusted on only adhering to the soluble parts which had absorbed moisture from the steam. In this case it is of course necessary to print from a positive.

The next important step was by Fargier, in France in 1860. Fargier was the first to transfer the film of gelatine and pigment to another support from the one which held it during printing. His method consisted in coating glass plates with bichromatised gelatine and pigment, which after exposure was covered with toughened collodion. On immersing in hot water the collodion came away from the glass with the picture in contact. It will be readily understood that the development of such a film was a matter requiring delicate manipulation, and such as would have little commercial value.

In 1863 a process was introduced, which very strangely seems to have been hitherto ignored by the text books and those writing on the subject to-day, but which I would ask you to carefully consider as possibly throwing some light on the way M. Artigue prepares his excellent paper for carbon printing without transfer. This method of working was brought to the notice of the Photographic Society by Mr. Blair of Bridgend, who you will remember previously printed through the back of the paper. Full particulars will be found in the *Photographic Journal* for that year. Mr. Blair took plain paper and coated it first with a solution of gelatine soluble only in hot water, and allowed it to dry. It was next coated with albumen mixed with a little syrup—not enough to prevent drying—and again dried. Then the paper was floated on water for a *very few seconds*, and the surplus moisture blotted off. Finely divided carbon was placed on the surface, and with a camel's hair brush dusted over in all directions so that it adhered to the thin film of albumen, all the surplus powder being well brushed off. Blair points out that this must be done so that the surface is perfectly even in colour, and that when viewed by transmitted light, it is quite translucent. The paper prepared in this manner might be kept for any length of time and sensitised before use by floating the back on a solution of bichromate of potash. Blair in his lecture propounded a theory as to why the half-tones are preserved in paper thus prepared, which those interested will do well to refer to. The Artigue paper has certainly a gelatine substratum and the colour in a finely divided state is attached to this substratum by gum or albumen, probably the latter, as Blair tried gum for the purpose, but found it did not take so kindly to the surface of the gelatine as the albumen. It was more apt to run together under the operation of the brush, and leave small blank spaces, and was also more tacky under moisture, and took up too much pigment.

In 1864 Swan took out a patent for making carbon prints, and his method with one or two improvements, which were subsequently made by Johnson, Sawyer, and others, forms the commercial process to-day. The two prints which I have here were done in 1864, or the beginning of 1865, by Annan, Swan's second licensee; they are,

I think you will admit, absolutely perfect in technique, and are as beautiful as anything we can produce to-day. The materials required for carbon printing are very few, and the process is such an extremely simple one that I wonder more amateurs have not taken it up; however, now that it is getting the odour of antiquity about it, it is becoming more popular, and one sees an increasing number of prints in carbon at the various photographic exhibitions. I propose to-night to develop two or three prints by the ordinary single transfer process, and also two or three by the Artigue process, which involves no transfer whatever, and I hope these latter prints will contain enough harrowing detail to satisfy even "Dogberry."

Materials required for Single Transfer Process.

Carbon tissue.	5 per cent. alum solution.
Thermometer.	Blotting boards.
Single transfer paper.	

The names, single and double transfer, frequently worry the beginner, but one process is as easy as the other, indeed it is the same thing with one additional operation.

Carbon tissue is the name given to a paper coated on one side with gelatine and pigment. Instructions for making it will be found in the text books, but I rather fancy all my hearers will prefer to procure the excellent commercial article which may be obtained in almost any colour.

Single transfer paper is any paper which has been so prepared that the tissue will adhere to it when squeegeed in contact. To render any paper suitable for the single transfer process make a solution of,

Nelson's No. 1 Gelatine	...	...	...	$\frac{1}{2}$ ounce.
Water	...	...	...	10 ounces.

Allow the gelatine to soak for an hour in the cold water and then dissolve by means of a water bath. When the gelatine is perfectly dissolved, stir into the solution half a dram of formalin. By means of a sponge or brush this may be applied to the surface of the paper and allowed to dry. Very thick drawing papers should receive two coats of the gelatine solution. Paper prepared for single transfer may be bought ready for use if preferred.

Having the materials enumerated above, we proceed to sensitise our tissue, although it may be purchased ready sensitised and keeps in good condition about a fortnight. Still if the operator has time at his disposal it is better for him to do the sensitising himself. He is then able to prepare just enough for immediate requirements, and moreover more varieties of colour may be purchased in the unsensitised condition. To sensitise the tissue, it is immersed in a 5 per cent. solution of bichromate of potash for 3 minutes in winter or 2 minutes in summer. Care must be taken that the temperature of the solution is not over 60° F. The tissue when withdrawn from the bichromate bath is squeegeed into contact with any smooth surface, such as a sheet of zinc, ferrotype, or glass plate, then withdrawn and placed film upwards upon a sheet of blotting paper, laid upon a piece of card which has been bent into a half circle. When dry, the tissue is ready for use. Another method is to let the tissue dry in contact with an enamelled iron plate. This is an advantage with transparency tissue for making positives which it is afterwards intended to enlarge. The operation of sensitising should be performed in a subdued light and the drying must take place in the dark, or in a room lit with non-actinic light. I usually prepare my tissue at night and place it to dry in my dark room. It is ready for use in the morning.

Before printing it is necessary to prepare the negative by making what is called a safe edge. This is done by placing an opaque mask on the glass side of the negative or a semi-opaque one on the film slide. Sometimes a band of black varnish is painted all round on the glass side. A very simple plan, and one that I usually adopt, is to stick a lantern slide binder round the edge of the plate. The object of this safe edge is to prevent the film coming away from the transfer paper. If a dense shadow comes

right up to the edge of the print it is likely to get washed away by the water getting under it unless the edge is gradually vignetted off. Such dense shadows being composed of insoluble gelatine of considerable thickness are only lightly attached to the support, and consequently it is necessary to have an edge of more soluble material which holds with greater tenacity to the support, and at the same time offers a more gradual resistance to the water.

It is evident that we must have some means of gauging our exposures, for the progress of our print cannot be told by looking at the very dark coloured surface of the tissue, and for this purpose various actinometers have been devised. I pass round for your inspection several forms of this apparatus.

Having decided what tint we are about to print our actinometer, we expose both it and the printing frame with the negative in contact, to light at the same time. For the first print it may not be quite easy to know to what degree to print the actinometer, but a little experience will soon get over the difficulty. When the actinometer is printed to the extent we think necessary the printing frame is withdrawn.

Now let us think what has been the action on our piece of printed tissue. A certain amount of light has probably come through all parts of the negative and covered the gelatine surface with a thin insoluble film. Through the more transparent parts of the negative such as the deep shadows the light has acted strongly, and in the corresponding portions of the tissue there is a thick film of insoluble gelatine. In fact the thickness of the insoluble gelatine is in exact proportion to the amount of light which has passed through the negative. This insoluble film being on the surface of the tissue, if we were to attempt to develop it the image would float off the paper support and be lost.

We must therefore transfer the image so that the insoluble portion which will ultimately form the picture remains in contact with a temporary or final support during development.

In the single transfer process we immerse one of the specially prepared sheets of paper in water some little time before we intend squeegeeing the printed tissue in contact with it. Whatman and other thick rough drawing papers should soak for some hours, or they may be immersed in hot water for about 20 minutes till all the air is driven out of the pores of the paper. The transfer paper being ready we place a piece a little larger than the tissue in a dish of cold water, in which the printed tissue is also immersed, when the tissue begins to flatten out, it and the paper are removed from the water together and squeegeed into intimate contact by means of a flat squeegee. After remaining under pressure between blotting boards for 10 minutes (or if a thick rough transfer paper is used for 20 or 30 minutes) the tissue and support are immersed in hot water at about 110° F. When the gelatine begins to ooze out round the edges, the back surface of the tissue is pulled off, and the print on its new support is developed by laving with hot water. It is advisable to have a sheet of glass in the developing tank, on which the print may be laid, and the warm water may be poured from a jug or measure on to the surface. Dark shadows may be considerably lightened by pouring hotter water from a greater height on to the print. Under-exposed prints may be modified somewhat by developing in cooler solutions.

It should be borne in mind that the print is a little darker when dry, and it must therefore be developed rather lighter than desired in the finished picture. After development the print is rinsed in cold water, and then placed in a 5 per cent. solution of alum, where it remains till all the yellow stain of the bichromate is removed from the paper. A rinse in cold water completes the operation, and the print is hung up to dry, after which it may be trimmed and mounted in the usual manner.

Such is the single transfer process, but in this process the print is reversed as regards right and left, a matter of small importance in purely artistic productions, but which could not be tolerated in a print of topographical interest or some portraits. To obviate this it is necessary to either make a reversed negative, which is troublesome unless an enlargement is required, or else to make a double transfer print. For double transfer we proceed exactly the same as for single transfer, except that

we develop the picture on a piece of finely smoothed opal or one of the flexible temporary supports which are articles of commerce. Whichever temporary support we decide on using it must be coated some time beforehand by rubbing a few drops of solution over its surface composed of

Pure bees' wax	...	...	...	...	2 drams.
Yellow resin	...	...	...	...	6 drams.
Turpentine	...	...	...	...	1 pint.

Some minutes after applying the waxing solution any excess should be polished off by rubbing a clean cloth in a circular motion all over the surface of the support.

These supports may be kept coated ready for use.

The image being developed on the temporary support may be transferred at once or left till dry. The latter is perhaps the best plan, as there is then no danger of damaging the film when squeegeeing. Paper coated with a film of partially soluble gelatine is sold for final supports, and a piece of this is immersed for half an hour in a 2 per cent. solution of alum. It is then placed in clean water with the print on the temporary support, the two are brought together, care being taken to avoid air bubbles between them, and after withdrawal from the water are vigorously squeegeed. Place between blotting boards for 12 hours, and then remove to a well ventilated room. The print will after some time detach itself from the temporary support and be found on its new surface ready for trimming and mounting.

With regard to placing clouds in carbon prints, most of my work has consisted of enlargements, and in this case I put the sky on the intermediate transparency. To insert clouds, however, one has only to make a mask of yellow paper, or if preferred, a silver print may be used, cutting out the sky and using it as a mask. If this is made to accurately register with the edge of the negative it may be placed on the carbon print in proper position, and the sky negative over it. During printing the edge may be softened by moving a piece of cardboard up and down along the horizon line.

For enlargements from small negatives I do not think any process can approach carbon. If a carbon transparency is made from the original all the delicate gradations are faithfully preserved without any difficulty. I do not say as good a result cannot be made when using a dry plate for the intermediate transparency, although with a dry plate transparency the result is never so certain.

I had nearly forgotten one point concerning carbon printing which is of considerable importance, viz., the continuing action of light, which proceeds with considerable rapidity according to the amount of moisture in the air. This action is also affected by temperature. A print at night may be not nearly enough printed, but by the morning may be considerably overdone, although it has been kept in a dark place. A few hours will make a great deal of difference in a carbon print, and it is therefore always advisable to develop as soon as printed.

CARBON PRINTING WITHOUT TRANSFER.

A great deal of nonsense has lately been written about the impossibility of making satisfactory carbon prints without transfer.

The writers are apparently theorists without manipulative skill, for I think you will admit the results that I am enabled to show through the kindness of M. Demachy of Paris by the bichromated gum process and my own prints on the Artigue paper, all prove that the most delicate gradations of tone can be rendered without transfer. I do not suggest either of these processes are easy or likely to become commercial, for a commercial process must almost of necessity be a mechanical one. The bichromated gum process is the oldest form of carbon printing, and, I think, owes its resuscitation in France to M. Rouillé-Ladevèze. M. Demachy is one of the most enthusiastic advocates of the method, and his works suffice to show the value of the process.

It consists in coating paper with a mixture of gum, bichromate of potash and pigment, and after exposure washing away the portions not affected by the light. A very easy process thus described, but as M. Demachy points out, a difficult one in reality. In a letter to me accompanying the prints he says:—

“The final result is modified to an incredible degree by the preponderance of

gum or pigment in the mixture and by the method of coating the paper. The same identical mixture spread thick or thin will give pictures of a quite different nature. I find it difficult, but the results when coating and exposure have been successful, are so interesting that notwithstanding its difficulty it is the most fascinating process I have ever used."

The Artigue Papier-Velours is a fine white paper coated on its surface with a warm black pigment of a beautifully matt appearance. If held up to transmitted light you will notice that the colour is spread very evenly over its surface and that the coating is exceedingly thin. This thin even coating which the light can easily penetrate is, as I previously pointed out, a necessity of the process.

The paper is prepared for use by immersion for two minutes in a 2 per cent. solution of bichromate of potash. Great care must be taken not to touch the surface of the paper or the colour will leave it. After immersion hang the paper up by clips to dry in a dark room.

Printing may be performed with an actinometer in the same way as with ordinary carbon tissue, although a safe-edge on the negative is not necessary.

To develop the image, the print is first placed in warm water at a temperature of 87° to 90° F. till the image begins to appear. It is then transferred to cold water for a few moments, and laid on a support such as a sheet of glass a little larger than the print, being held in position by two metal paper clips at one end.

A mixture of a fine sawdust—specially prepared by Artigue for the purpose—and water is necessary to complete the operation. This mixture should be of the consistency of good pea soup, and may be kept at a temperature of 65° or 70° F. The print with its glass support is held over the bowl containing the mixture, which is poured along the top edge so that it runs evenly over its surface. The sawdust mixture drags the colour off of the print where the light has not affected it, and in fact acts like a small file. It is more even and gentle in its action than a brush. The print is rinsed from time to time in order to examine whether it is exactly as required when finished. Very dark shadows may be lightened by pouring the sawdust solution in a little stream on those parts, and the paper is more amenable to local action than ordinary carbon tissue. The sawdust solution may be kept for a very long time, that which I am using to-night having been in use for several months.

After development the print is washed and then immersed in a 5 per cent. solution of alum to remove all traces of the bichromate salt, then dried, trimmed and mounted as usual.

M. Artigue suggests sensitising the paper by painting the back with bichromate solution, but I have never found this so satisfactory as the immersion method, although theoretically it is better.

The great charm of this method of carbon printing is the command over the final result which the worker can exercise. By means of a brush all sorts of effects may be produced on the wet print, the pigment on the surface being very lightly attached is easily removed. Mr. Maskell has for some years preached up the merits of the process for artistic work, and possibly his results, admirable as they are in the eyes of some people, have deterred those who required purely technical excellence from trying the process. I hope to have shown that no process more faithfully reproduces the most exquisite detail and half-tones.

From what you have seen to-night of the rival methods you will be able to judge as to their merits. Commercially the transfer method will always stand pre-eminent, because the results can be turned out easily by anyone. I have however laid particular stress on these methods of work without transfer not only on account of the peculiar beauty of result, but in order that you may see how little ground there is for the statements concerning them which have lately appeared in the photographic press.

In the course of the lecture Mr. Sinclair fully demonstrated the methods of developing the ordinary carbon tissue by single transfer and also the Artigue process, in the methods indicated by his remarks. He also exhibited a number of prints by those processes, and examples sent by M. Demachy and Mr. Swan. In answer to a

question as to the method of using Burton's actinometer, he said that for a negative equal in density to No. 3 on the actinometer it would not do to print until silver paper was fully printed out under that part of the instrument, but No. 1 would probably have to be taken, as carbon tissue was about three times as rapid as silver paper. Some doubt had been thrown on this latter statement, but by repeated experiments he had satisfied himself that it was correct.

A vote of thanks was passed to Mr. Sinclair for his lecture and demonstration, and to M. Demachy and Mr. Swan for their kindness in sending prints for exhibition.

III.

COLLOTYPE.

By Mr. W. E. DEBENHAM.

Friday, April 24th, 1896. Mr. Chapman Jones, in the Chair.

COLLOTYPE is the art of printing in the manner of a lithograph from a film of gelatine which has been made selective in its taking up of a greasy ink by the action of light.

The first principle on which colotype depends, is the principle involved in lithography, *i.e.*, that a surface containing moisture refuses to take a greasy ink, whereas the parts of the surface which do not contain moisture take the ink freely. The next thing to note is that gelatine, when treated with a chromic salt and exposed to light, undergoes a certain change by virtue of which it does not absorb cold water, whereas the unaltered gelatine does so. Where, therefore, the surface has been exposed under a negative, the shadows which have been acted upon by light take on a condition wherein the gelatine refuses to absorb water, the parts which have been shielded from light remaining unaffected, and absorbing freely; so that if the chromium salts are washed out, we get a condition of things very like that of the lithographic stone on which a design has been traced with a greasy ink. The first difficulty that occurred in endeavouring to apply these principles to the production of a printing surface was this,—that the gelatine was found not to adhere to the support to which it might have been attached, but to strip off along with the inking roller; it was necessary to have some surface as a support, and, whatever surface the gelatine was poured on to, the water soaked through the gelatine to the back and loosened the attachment, so that when the roller was passed over it the whole of the film came up. Albert, of Munich, overcame that difficulty in a very ingenious way. He coated plates first with a mixture of bichromate and gelatine, and a certain quantity of albumen; this was dried, and the plate exposed to light through the back, by placing it on a black velvet cloth, glass side to the light. By this means the surface next to the glass was rendered so hard that the water did not soak quite to the back of the film, and consequently after washing in warm water an adherent substratum was formed, the back of which was quite hard, while the gelatine on the surface remained in a soft, spongy, condition. A new sensitised film of bichromated gelatine was then applied, and adhered thoroughly to the soft upper surface of the substratum.

That was a very good process, and was worked with great success, but it was found more convenient to adopt some substratum which would be independent of a light action. Such a film was successfully made by a mixture of water-glass (silicate of soda) and some organic matter. The organic matter at first used was white of egg, but it was not long before a compound was found to substitute it—ordinary ale, which has an advantage over white of egg in that it does not froth so continuously. Ale contains some glutinous substance in just sufficient quantity, when mixed with the water-glass, to give the desirable porosity of film, and, in fact, a film which answers very well as a support for the sensitive surface.

The great enemies against which a colliotyper has to guard are dust and air bubbles. The various safeguards and precautions which will be detailed are intended

to ensure regularly successful work, and although I am aware that some one of them may be dispensed with by certain successful workers and some by others, it is advisable, at all events for the unpractised, to omit nothing which tends towards the perfection of the work.

The support on which the collotype solutions are spread is plate glass, which may conveniently be of $\frac{1}{4}$ or $\frac{3}{8}$ of an inch in thickness, and should be large enough to leave a margin of at least two inches on each side of the printing surface. The sharpness of the edges should be taken off by grinding, and on the upper side it is well to grind away the edge, until there is a bevel. When for use in a press furnished with grips, the bevel is ground both deep and true along the sides and ends.

The first thing to do is to prepare the glass to receive the coating of water-glass and beer, and this is done by grinding. If the glass has already been used for collotype and has to be used again, the old film must be very thoroughly cleaned off; this is often done by immersion in a stoneware trough containing strong sulphuric acid, but sulphuric acid is not nice stuff to have about, and another solution is found to answer just as well, namely, caustic soda, prepared extemporaneously by mixing a solution of ordinary washing soda with lime. If, however, the plates have not been used before, it is simply necessary to grind them. A pair of plates is ground by placing them on a flat surface and grinding them together with fine emery powder, called emery flour, and a little water between. If in grinding new glass you find one or two places remain bright, that shows the glass is not quite flat, and you may then expedite the work by using a coarser emery—say 120,—finishing off with emery flour to produce a finer surface. When the plates are properly ground the powder may be brushed off under a tap, being careful to thoroughly wash the edges, in the roughnesses of which a little powder is apt to stick.

When dry the plate is coated with the water-glass mixture;—

Water-glass	...	...	...	1 ounce by measure.
Beer	...	...	...	15 ounces do,
Crushed caustic soda	...	...	...	30 grains,

Caustic soda is not always used, but it is a desirable addition, particularly if the beer is in the slightest degree sour; if the beer begins to cloud almost directly after filtration, you may depend upon it that in the course of drying on the plate it will throw down particles which it is undesirable to have. Ordinary "four ale" is often used for this purpose, and I have used it with great success; beer, however, which may be depended upon, is "Pilsener" beer, as may that which I am using for my demonstration, "Späßen" beer. It is desirable to filter the ale several times to get rid of gas, and a good plan is to pour it many times from a height from one vessel to another. A material which is very useful as a preliminary filter, and in several departments in collotype, is that sold as "butter-cloth"; a soft muslin without dressing. If the beer is acid more caustic soda may be added. The final filtration is through filter paper. To prevent the formation of bubbles in filtering, it is desirable to place the funnel at such a height, and in such a position in the receiving vessel, that the mixture trickles down the side instead of falling in drops.

The next operation is to coat the clean glasses with the beer mixture. There are many ways of doing that,—I have often held the plate in my hand and poured the mixture from a jug, but we will do it in what is now a more usual way, and is certainly more convenient for large plates. The glass is levelled by means of a levelling stand and a spirit level, and stands over a large porcelain dish. Having removed any bubbles or scum which may be on the surface of the mixture, carefully dust the plate by lightly passing a broad soft brush over the surface, and then pour a pool of the mixture on the glass, covering the surface of the plate along the edge nearest to the operator, and by means of a bow made of cane and catgut, *push* a wave of it all over the surface,—do not *drag* it. That is to say, do not let the gut scrape the dry part of the glass. Indeed it is best not to let it scrape anywhere except at the extreme edge of the plate, where it may touch to ensure the liquid flowing up to the edge. The surplus solution is then poured off, and the plate stood in a rack to dry. In dry summer weather no artificial heat need be used, but if the weather is cold or moist the plates

should be dried by gentle warmth. For draining and drying, ordinary plate racks may be used, but the grooves must of course be broad enough to carry the thick plates, and it is helpful in preventing dust to tilt the plates so that the coated side is a little downwards. This can be conveniently done in an ordinary household plate rack.

We will now prepare the actual sensitive coating. Here is some gelatine, one ounce, which has been soaking for an hour or so, and then drained; the gelatine should neither be of a very hard nor very soft kind. What is known as "middle-hard" by Creuz is what I am now using. The water that this has been soaked in has been boiled and allowed to cool before the gelatine was put in it, in order to minimise the risk of bubbles by getting rid of the air from the water. To one ounce of gelatine thus swelled in water I add two ounces of a 10 per cent. solution of mixed bichromates of ammonia and potash, and then I place the jug containing the mixture into a vessel of hot water for the gelatine to melt. When melted the solution is made up, if necessary, with water to $12\frac{1}{2}$ ounces; I add also half a dram of ammonia to the bichromate solution, and $1\frac{1}{2}$ drams of a 5 per cent. chrome alum solution, which is useful for hardening the gelatine, and forming the particular grain which it is desirable to have. Whilst pouring in the chrome alum solution, the mixture must be briskly stirred.

The filtering apparatus for this gelatine mixture is a saucepan with a hole in the bottom into which a spoutless tin funnel has been soldered, and by putting hot water between the funnel and the saucepan the gelatine solution is kept in a liquid condition.

Before the gelatine solution is finally filtered, it should be strained through a double thickness of butter-cloth, which gets rid of the coarser particles and prevents the filter paper from being quickly clogged. Another method of filtering is to put the solution into a vessel like a lamp chimney, with a piece of wash leather tied over the base; through this, the solution is forced by air pressure from a tube and bulb passed through a cork in the top of the glass, but I do not think there is anything better than filter paper for the purpose. Having filtered the gelatine mixture and carefully dusted the plate as directed for the first coating we coat the plate as before, using a similar catgut bow, but not the same one as was used for the beer and silicate solution. For this operation the plate need not be levelled so carefully as when it is put in the drying cupboard, as the only object in levelling now is to prevent waste of the solution by spilling it. A help in avoiding bubbles and scum which I saw in use at Alberts' and am using now, is to keep a jug of the coating mixture quite full standing in warm water for some time, and immediately before use blow off the surface liquid into another jug or into the filter. Many workers measure the quantity to be used in coating, and there is something to be said in favour of this plan, and something against it. If it is not measured of course we cannot be certain that we have exactly the same thickness of gelatine on each plate; but, on the other hand, if it is not measured we can pour on sufficient to allow of some being swept off, and that helps to get rid of bubbles and dust. The surplus solution, as with the water-glass mixture, may after filtration be added to the stock. The two ends of the bow cord must not touch the solution at the same time, or there would be a scraping action which is prejudicial to proper coating; when coated, the plate must be placed in the drying box and left there for an hour or so, during which time the box must not be opened or the plate would be spoiled. A method of coating which is a good deal used, and which may have the balance of advantages for very large plates, is to pour on the solution whilst the plate is in the drying box itself. With this method of coating, a glass rod bent in a triangular form, is generally used instead of the bow. The objections to the plan are, that it is not so easy to detect air bubbles or dust in the solution when poured on, or to remove them by flooding with a fresh quantity. A thick film prints slowly under a negative, and a thin film, although printing quicker, is apt to print black all over; the quantity of solution left on the plate should be about an ounce for a 12×10 plate. If you adopt the measurement plan once or twice you will see what the thickness of film should be, and you will then know what appearance a film of suitable thickness presents when coating without measurement afterwards. The sensitive solution is not costly, and it is not advisable to keep it, although I have sometimes used it without ill

effects the day or even two or three days after mixing. If the coated plate is kept, the film becomes harder and more liable to take ink on the lights; but, on the other hand, it has rather more of what is called "grain," which makes the plate nicely workable, and gives the half-tones very well. Mr. Wilkinson recommends preparing plates in pairs and storing them face to face, which seems reasonable; some authorities, however, have said that nothing whatever should touch the surface, but perhaps it had not occurred to those workers to consider the effect of contact with a like body. Any damp on the surface would, of course, be destructive.

The drying box, or oven, is a box the bottom of which is made of sheet-iron, and on that bottom is a sheet-iron dish turned upside down, which forms a false bottom so that the heat shall not radiate too strongly in any particular plane. Across, near the top, are wooden bars supporting a grill which is tapped and fitted with screws, points upwards, accurately brought to one plane. In this particular box the screws for levelling are outside, and before the plate is coated it is placed in the box and carefully levelled. It is well to note which edge of the plate lies to the front during the levelling process, and replace it in the same position after coating. The plate is left in the drying box until thoroughly warm, and then coated.

The great points to be observed while the plate is drying, are that it must be preserved from draughts, from dust, and from shaking, even walking about ordinary flooring in the vicinity of the box will cause wavy marks; if possible, it should be let into a corner where there is a stone floor, and consequently little risk of vibration. It has sometimes been found impracticable to carry on collotype work at all, by reason of the proximity of machinery to the drying box, the tremor communicated to the plate during drying, causing lines and markings upon it. The lid of this box is a frame lined with muslin and covered with black calico, materials which allow a certain amount of moisture to pass through; and there is a thermometer fixed in it with the scale sticking up, so that it can be read from the outside. The plate should be dried at a temperature of from 120° to 130° F. The temperature at which the film is dried will affect the nature of the grain; if the drying box is kept at about 110° there is scarcely any grain, while at 140° there is almost too much or too coarse, and the best temperature in most cases is between 120° and 130° ; the chrome alum also assists in the formation of grain.

The next thing to be considered is the preparation of the negative for printing. It is desirable to have at least two inches of white margin all round the plates, and this is secured by putting a border of tinfoil on the face of the negative. Paper is too thick for this purpose, as it would prevent contact between the plate and the negative, and there would consequently be no sharpness. If an ordinary negative is used the final print will be reversed, which in some cases does not much matter, but if an unreversed print is required one of several things can be done. When negatives are specially taken for collotype a prism is generally used with the lens; when this has not been done an ordinary silver print can be made and copied with a prism, so as to obtain a reversed negative, or a copy can be taken on a collodion plate and the film stripped off, and the same plan can be adopted when the original negative is taken on a collodion plate. The stripped film method is that most commonly utilised. The plate is prepared with a waxing solution, coated with collodion, and the negative taken by the bath process. When it is thoroughly washed, a solution of gelatine with a little glycerine added is poured on, and in the course of the next day the film should be dry and can be stripped off. Another way is to squeegee a piece of sheet gelatine on to the gummed surface of the film, by which means you can get your films all of one thickness. A great convenience of stripped films is that you may use a large collotype plate for as many subjects as it will hold, covering the joints with tinfoil.

Printing is sometimes judged by examination from the back, but the actinometer method is to be preferred, and a very simple actinometer, which anyone can rig up, is formed by a negative which is taken as a standard of unity. A slip of silver paper is printed from this simultaneously with one from the negative for collotype. The time occupied in printing will of course depend very much on the negative, but it may usually be taken that the exposure will be about three times that required for a silver print. When printed, the plate is taken from the pressure-frame and allowed to soak

in cold water for an hour or two, until you can see no colour whatever in the light parts, and only the merest trace of colour in the shadows, and when thoroughly dried it is ready for the printer.

There are two or three ways of printing. One is simply to damp the plate as a lithographic stone is damped, dabbing off the moisture from the film—but not wiping it—until you can see no shining spots of water, and then begin to ink; a much more common method is to pour on what is called an “etching solution,” generally composed of glycerine and water, and a little salt. The following makes an ordinary sort of solution:—

Glycerine	...	...	...	...	...	5 ounces.
Water	...	...	...	...	...	3 ”
Salt	...	...	...	...	...	1 drachm.

The plate is levelled and the solution poured on deep enough to make a pool all over it, and there it may stand for a few minutes or an hour or two; if much printed a rather long soaking is necessary. The use of this solution enables many prints to be pulled without re-damping, whereas if the plate is simply damped with water it must be re-damped for each print. With the etching solution you may, without stopping to re-moisten, get from 20 to 50 prints from a hand press, or as many as 150 or even more by machine printing. There are two reasons why machine printing gives so many more prints than a hand press; in the first place, the work is so much faster that more work is done before the moisture evaporates; and, in the second place, the paper in machine printing is only in contact with the plate for a very short time, and consequently very little moisture is absorbed by each print. When the plate has been “etched” for some time the solution is removed with a sponge, and after finally dabbing the plate with a soft cloth the rolling may begin.

The etching solution may be used repeatedly, being strained through muslin after each time in order to keep it clear. The press used for the demonstration is an ordinary lithographic press; presses are especially made for collotype, resembling good litho presses with the addition of an appliance for steadying or grasping the plate. When using a litho press a litho stone, somewhat larger than the collotype plate, is laid on the bed, and the plate is secured on the stone, either by bedding with plaster of Paris, or, as I am now doing, by means of a pair of long clips which bind on the edges of the stone close to the ends of the plate, and are secured by wedges driven in against the edges of the stone. Other suitable mechanical appliances may of course be adopted.

The water or etching fluid being sponged off, and the surface moisture removed by dabbing with a piece of butter-cloth until no more glistening specks of moisture can be seen, a litho roller, charged with a somewhat stiff ink, is passed over the surface. The ink is what is known as a lithographic chalk ink, and it is desirable to use a high quality. It will probably be a little too stiff as sold, and is thinned by the admixture of a very small quantity of lithographer's varnish, which is, essentially, thickened linseed oil. After rolling in with this ink, the half tones will generally be too faint, or not show at all in the lighter portions. The plate now receives a second inking with a somewhat thinner ink, applied with a glue roller, such as is used for letterpress.

Various kinds of paper may be used, but it must not be of a soft and spongy character, otherwise it may split up, leaving part of it adherent to the plate. The best to use for most purposes is some prepared with an enamel surface expressly for collotype. Inks of various colours may be used, and if it is desired to represent the glaze as well as the colour of a print upon albumen or gelatine paper, the print is floated upon a varnish of bleached lac dissolved with the aid of borax or of ammonia and alcohol as in the following formula:

Two ounces of powdered bleached shellac are dissolved in a mixture of six ounces of alcohol, and five ounces of strong ammonia. Ten ounces of boiling water are added little by little with constant stirring. The solution is afterwards filtered two or three times. For the final filtration a material known as nainsook is suitable.

If any bubbles are formed in varnishing they may be removed whilst the solution is still flowing by touching with a sable pencil dipped in the same liquid.

The management of the rolling and of the press is rather an art by itself, and the photographer who thinks of taking up collotype would do well in the first instance to obtain the assistance of a skilled lithographic printer, until he has acquired some practice in this part of the work.

The process of inking the collotype plate and pulling proofs was then demonstrated, in the course of which, in answer to questions, Mr. Debenham said—

An ordinary copying press cannot be used for anything larger than a quarter plate, as it does not give sufficient pressure to pick up the ink, but it can be utilised for a modification of collotype known as the photo-auto-copyist. Any good negative will do for collotype printing; if the negative is weak, the plate may be improved by inking it and pouring on the so-called "etching solution," with the addition of a little ammonia, in which case, the shadows being inked, are protected, while the lights are cleared up, and a fairly vigorous print may thus be obtained from a weak negative. The negative should be as free from spots as possible, but something may be done to remedy them on the collotype plate. If there are white spots in black places you may grind up a little black colour with a solution of tannin and just touch the plate with the mixture, when the tannin will so harden the gelatine that it will take the ink. It is desirable, when doing this, to ink the plate first, because the white spots can then be easier seen, and the ink protects the surrounding parts from spreading of the tannin solution.

A vote of thanks was passed to Mr. Debenham. In replying, he said he considered collotype to be the best method of photo-mechanical printing, although it might not be the most adapted for commercial purposes, where very large numbers are required. Block printing is now done exceedingly well, and could be turned out very much cheaper than was possible with collotype; but for the true rendering of nature, without loss of detail or gradation, he did not think there was any mechanical process to equal that which had formed the subject of his lecture.

The proceedings closed with a vote of thanks to the Chairman.

IV.

WOODBURY PRINTING.

By J. D. GEDDES.

April 28th, 1896. Mr. W. Thomas, in the Chair.

THIS process, which has obtained its name from that of its inventor and founder, the late Mr. W. B. Woodbury, has now been before the public for a period of about thirty years, and it is generally admitted to be the most interesting and beautiful of all photo-mechanical processes. It was patented in the year 1864, and it is curious to note that the details of the process then protected are practically the same as the working to-day, showing that the genius of the inventor covered the whole ground, and that it has not been found possible since to discover any material modification which would affect the results obtained. Of course, there have been variations adopted from time to time, one of which, Woodbury gravure, I shall have a word to say about later on, but as regards the invention itself, Woodbury printing of to-day is almost precisely what it was twenty years ago, and it is singular in this respect—other photo-mechanical processes have been improved and advanced during the same period out of all knowledge, yet with this one the inventive genius of its founder was such as to leave scarcely a point unprovided for, and with a completeness that must always be looked upon with wonder and admiration.

You have had several lectures already in the present series dealing with the principles and phenomena of printing with gelatine and bichromate salts, and it is happily not necessary for me to enter into any of the details relating to the chemical and scientific questions appertaining to the behaviour of the salts of chromium in combination with organic substances.

The subject of my remarks this evening is essentially founded on the invaluable property which so much use is made of in all photo-mechanical processes, viz. : the hardening action of light upon gelatinous substances sensitised with a bichromate salt, and the *modus operandi* of Woodbury printing may be briefly described as follows :—

1. The first process is the preparation of the sensitised tissue. A sheet of plate glass is cleaned and rubbed over with talc, collodionised and dried.
2. Gelatine, 2 parts, glycerine or sugar, $\frac{1}{2}$ part ; potassium bichromate, 2 parts ; water, 15 parts, is made hot and poured over the collodionised plate and dried in an oven with calcium chloride.
3. The sensitised film is then stripped off its support and exposed under any ordinary good negative, the time being judged by an actinometer.
4. It is washed in hot water, and
5. Dried off in spirit.
6. It is then forced into a sheet of lead by hydraulic pressure.
7. The lead impression so obtained is fixed in the press and levelled.
8. The lead is covered with ink, a sheet of paper laid on, and printed.
9. When the ink is set the print is removed, immersed in alum, dried, trimmed and mounted.

Operations.

A plate glass is carefully cleaned and rubbed over with wax or talc ; the coating must be very thin,—this prepared glass is then coated with a strong and tough collodion, and allowed to dry. The plate is then covered on the collodionised side with a thick warm solution of gelatine containing about 15 per cent. of bichromate of potash with a little sugar, glycerine, and colouring matter. The bichromate of course renders the coating sensitive to light, and the sugar and glycerine render it pliable and less brittle ; the colouring enables the operator to better judge the quality of his picture. The plate thus coated is placed on a levelling stand to set, and when set is removed to a drying box containing dry chloride of calcium, which absorbs the water and soon dessicates the gelatine. The film of collodion and gelatine can now be stripped from the glass, and is ready for exposure under any good ordinary negative.

The second operation consists in exposing the film—the collodion side is placed in contact with the negative surface, and the exposure is made as nearly as possible with direct rays either of sun or electric light ; the film of insensitive collodion has an appreciable thickness, and unless direct perpendicular rays are employed for the printing, the image would suffer from want of sharpness. There is also another reason why straight rays are a necessity, the sensitive film being semi-transparent permits the light action to penetrate an appreciable distance into the substance of the film itself, and, as will shortly be apparent to you, if the light was diffused, would cause a blurring of the image—in fact, much the same effect as would occur were we to try to print from the glass side of a negative.

The third stage in the process is the washing out of the unacted-upon portions of the exposed film. To do this the collodion side of the tissue is laid down on a sheet of glass which has been freshly coated with a solution of india-rubber in benzol. The tissue securely fixed to this base is then plunged in warm water and gradually heated to nearly boiling point. The period of washing occupies some 7 or 8 hours, during which time the water is constantly changed. The effect of this washing is, as I have stated, to dissolve away all the gelatine not rendered insoluble by the penetration of light through the negative, and on the perfection of this operation depends the whole success of the working : providing the exposure is correct, the whole of the gradations of tone in the negative will be rendered in the tissue by varying thicknesses of gelatine ; the deepest shadows will be represented by the thickest portions, and all the intermediate tones being, so to speak, engraved out of the substance of the tissue, until the highest light (and consequently least acted upon portion) is represented only by the collodion base upon which the relief is built. When the washing is deemed sufficient, and that is determined by there being no evidence of solubility in the relief, the

tissue is dried by immersion in clean methylated spirit, and afterwards spontaneously. This completes the relief, and it is now ready for the fourth operation, *i.e.*,—

Making the printing mould or die,—and it is here that the more surprising part of the process is evidenced. This apparently delicate and silk-like film has next to be bodily forced by enormous pressure between steel plates into a sheet of soft metal, which soft metal ultimately forms the printing surface from which the pictures are produced. A plate of hard steel varying in thickness from $1\frac{1}{2}$ to $2\frac{1}{2}$ inches according to the size of picture is obtained and rendered mathematically flat; to the four sides of this plate are bolted side plates projecting above the surface about $\frac{3}{8}$ of an inch, forming a kind of shallow steel box; the film is laid upon the steel surface, and over it is placed a sheet of hard rolled lead $\frac{1}{4}$ inch thick; the whole is then placed on the planed iron ram of a specially constructed hydraulic press, and subjected to a pressure of from 2,000 to 5,000 lbs. to the square inch according to the size of the picture. The result of the pressure is to impress in the metal in every smallest detail of light and shade represented in the relief, and forming an exact reverse of the “light mould” appearing in the gelatine. Thus the high lights represent elevations and the deep shadows depressions, in a *bas relief* of the negative.

The metal plate is removed from the steel block by unscrewing the bolts on the sides, and the film stripped from its bed, the latter uninjured and ready for the production of any number of further printing moulds or dies.

The next operation is to trim the printing mould and fix it in the special press devised for the printing, which is effected by softening a lump of gutta-percha in warm water and placing sufficient on the bed of the press to cover it, and spreading it out evenly by means of the smooth glass covered lid. On this bed of soft gutta-percha the mould is placed and allowed to remain until the bed is set, when it is ready for printing. The printing paper is composed of fine textured Rives paper, coated with a waterproofing solution of shellac in borax, and is subsequently highly rolled between polished steel plates. The ink used is also remarkable, and I can only liken it to a substance like calves’ foot jelly: it is in fact again gelatine, and is coloured to represent a photographic silver print tone, platinum, Bartolozzi red, with suitable pigments. The ink being composed of a gelatine base which sets if cold, is kept hot, and in this state is poured in a pool in the middle of the mould to be printed from, the mould being first oiled to prevent adherence, and a sheet of the waterproofed paper just mentioned is quickly placed on the top of the ink pool, and the heavy plate glass lined lid or top of the press is brought down with some pressure upon the whole, the result being that the gelatinous ink is spread and squeezed out over the whole surface of the intaglio mould, the hollows and depressions representing the shadows holding, so to speak, little ponds or pools of ink, and the elevations and high lights when the ink is pressed away, being represented by whites or light tints. A few minutes in the press suffices to set the ink and attach it firmly to the paper when it is peeled off, and the operation repeated for the next print. The print when examined wet from the mould is in high relief, and indeed is again a copy in coloured ink on paper of the original relief which was pressed into the metal plate. This relief, however, soon dries down, and as soon as dry is fixed by soaking in a solution of alum in water and washed. The print after drying is then ready for trimming and mounting as an ordinary silver print.

Having given you a brief *résumé* of the process of Woodburytype, I will now ask you to go through it with me, step by step, and I will endeavour to show you exactly how the process is worked.

Mr. GEDDES then demonstrated the several operations involved in Woodburytype printing. He said it was doubtful whether sufficient pressure could be applied to press the gelatine relief quite flat; attempts had been made to squeeze it into copper plates, but greater power was required than he had at his disposal; the relief was not at all injured by the pressure to which it was subjected in endeavouring to get it into the copper. The printing paper was finally prepared for receiving the image by being rubbed over with an emulsion of shellac and gelatine which gave it a sort of “tooth.” The mould was lubricated with a mixture of olive oil and paraffin. He did not think

the printing paper could be commercially obtained in London, but Messrs. Waterlow & Sons, Ltd., would probably be willing to supply it; they made it themselves for their own work. The emulsion for preparing the printing paper might be made by mixing gelatine with ordinary shellac varnish and shaking until the mixture appeared like milk; without an application of this kind the print was liable to split off the paper. Woodburytype appeared to be peculiarly adapted for the reproduction of portraits. It was a pity to say that there were drawbacks to such a beautiful process, but there were two rather serious disadvantages about it. In the first place, it had not yet been found possible to print with a clean margin, and consequently it was always necessary to trim and mount the prints; and, in the second place, it appeared to be impossible to apply a sufficiently even pressure to squeeze out the ink over a large white surface, such as the sky, and therefore any considerable expanse of white got rather smudgy. For portraiture, machinery, interiors, and for some classes of paintings, the variety of colour which could be obtained and the permanency of the work rendered it a valuable and very beautiful process. With regard to Woodburygravure, a method had been invented by, he thought, Mr. Burrows, of the Woodburytype Company, which to a certain extent overcame the mounting difficulty, and a modification of which was occasionally worked by Messrs. Waterlow. The latter was founded on the old india-rubber carbon transfer process; the print was made on paper coated with indiarubber solution, and transferred by pressure to plate paper, after which the indiarubber was dissolved by soaking in benzole and the original supporting paper removed, leaving the picture on the plate paper.

A vote of thanks was passed to Mr. Geddes and Mr. Ridgeway.

V.

PHOTO-LITHOGRAPHY AND PHOTO-ZINCOGRAPHY.

By W. T. WILKINSON.

Friday, May 1st, 1896. Mr. T. Bolas, F.I.C., F.C.S., in the Chair.

THE earliest account of a process of photo-lithography is that of Joseph Dixon, who, in 1841, copied bank notes by mixing gum with potassium bichromate, spreading the mixture on a lithographic stone, exposing to light through a bank note, and inking up the exposed stone and printing proofs in the usual way. Early in the sixties photo-lithographic transfers were used, but of late years they have, to a large extent, gone out of use, simply because of the want of a good understanding of the requirements of a good lithographic transfer, and also on account of the method adopted of inking up, which always produced transfers yielding dirty whites, and the unsuitable coating on the paper gave thickened lines.

The first point which we must discuss to-night is, what are the requirements of a good photo-lithographic transfer? To begin with, it is necessary that each line be sharp and solid, and that when the transfer is damp for transferring the ink lines must not be raised above the surrounding whites; *i.e.*, there must be little or no relief, while at the same time the gelatine coating must absorb sufficient moisture to cause it to adhere to the stone the first time it is pulled through the press. In the old days the paper was made at home, and the bichromate and the gelatine were mixed together; there was no care taken as to whether the gelatine was boiled to death or whether it was simply dissolved, and the paper was coated with a brush,—first one way, and dried, and then the other way, and dried again. Anyone who has studied the behaviour of gelatine in connection with the bichromate salts will know that that is not the best way of working gelatine. The first improvement was made when Husnik introduced his paper for photo-lithographic transfers, and from that time a slight reaction set in, and very good transfers were made upon that paper. Unfortunately, however, it occurred to Husnik to improve the paper, and he "improved" it with a vengeance,

he utterly spoiled it, and the thing died again. After some investigation I hit upon a paper which for this purpose is perfection itself, although it is prepared for quite another process; I allude to the double transfer paper of the Autotype Company, which, if floated upon albumen and bichromate and dried, really gives an ideal transfer, as it gives very little relief, will carry very little (but amply sufficient) ink, and in the press has a perfect grip on the stone. The preparation of the paper is extremely simple; the bichromate solution must not be too strong, and the paper must not be dried at too high a temperature. If when dry it has the slightest brittleness about it it is of no use, and will not produce good transfers. There are two ways of drying the paper. One method, adapted for what may be called commercial work, where a good deal is done and time is limited, consists in immersing the paper in a solution of bichromate until it is limp, but not until it curls outwards. It is impossible to give a time limit for this operation, because if the solution is at 60° the paper may safely be left in it for two minutes, but if warmer or colder the period of immersion will vary. When removed from the bichromate the paper is gently squeegeed on to a sheet of glass, wiped with a clean rag, stripped off, and hung up to dry in a well-ventilated oven heated to not more than 70° . The other method is to allow the paper to remain on the glass, in which case it may be dried in the dark in an ordinary room; when stripped off it will have a fine surface, and one can dispense with very heavy screw pressure frames for ensuring contact between the negative and the paper.

The question as to how long the paper will remain in good condition is determined by the manner in which it is sensitised and dried; if sensitised in a 1 per cent. solution it will keep longer than if sensitised in a 3 per cent. solution; but if sensitised in a solution of 1 per cent. of bichromate you introduce a number of difficulties.

The exposure to light under the negative is a very simple operation, and if you are only doing small transfers you can judge the exposure by examination, if you exercise a little care; it is always best, however, to use an actinometer, and for this purpose there is nothing better than a piece of a line negative in a quarter-plate printing frame. The negatives must have the lines perfectly clear, and the parts representing the whites should be as near opaque as possible; the wet collodion process gives such negatives with the greatest ease, but at the present time we can get process plates which with care will give the same results. The exposure to light must be continued until there is a well defined image on the transfer paper, of the colour of the print which I now send round.

After exposure comes the question of inking, and this is one of the rocks upon which the old photo-lithographers used to split. The original method of inking-up a transfer was a very ridiculous one; the transfer ink was thinned down with palm oil or some other oil, and the lithographic stone was rolled over with this greasy ink until it was covered with a thin even film, when the transfer was laid on the inked stone and the whole pulled through the press. By this means the grease was forced into the paper and it was almost impossible to get a clean transfer. Another process of inking was introduced, I think by Husnik, and in many respects was not much better; the ink was placed on the slab and thinned with turpentine, and then rubbed all over the transfer. This plan gave no control over the quantity of ink that was used, and this brought about another fault at which the lithographer grumbled—the lines were impaired. The modern way of inking up a transfer, for the introduction of which I may take credit, is very simple and quick, and is economical so far as the ink is concerned. The ink is thinned down on a slab with turpentine, and the print is laid upon a board and held in position by a hinge, then take a glue roller and use it to roll the ink over the transfer, continuing until the turpentine has evaporated, and there is a thin and even film of ink. The transfer is then soaked in water for a short time, after which the ink is rubbed off by means of a wet pad of cotton-wool. For the purpose of this demonstration I am using the specially manufactured photo-lithographic transfer paper, which is sensitised in—

Bichromate of potash	...	...	...	...	1 ounce.
Water	...	...	...	...	20 ounces.

For my own use, however, I prefer the double transfer carbon paper, which I sensitise in—

White of ten eggs.

Bichromate of potash 2 ounces.

Water 30 „

The question arises, which is the best bichromate to use? For photo-lithography, like collotype, I find the bichromate of potash is the best; bichromate of ammonia is uncertain in its action, especially in damp weather; the addition of a little liquid ammonia to the bichromate of potash certainly helps the ink coming off. When the ink has been cleaned off the transfer is blotted, and pinned by its four corners on to a board to dry, care being taken not to stretch it. Having been dried, it is trimmed and placed in a damping book until damp; it is usually tested by putting the tip of the finger on it, and if the finger adheres the transfer is ready for transferring.

The next thing to pass on to is photo-lithography in half-tone; this is a process which has received attention for some years, and I think the first commercially practical method was introduced by Bullock Brothers. I have with me, and pass round for your examination, some sheets of paper prepared for the Bullock method, and which is photo-litho transfer paper that has been pulled through a press on an inked grained stone; I also show some prints on this paper from which you will see how the image is broken up. We have only discussed the use of gelatine in connection with photo-lithography, but other of the colloids can be used; gum tragacanth is very good for coating the top of the gelatinised paper, but gum arabic cannot be used at all as it is almost sure to make its presence felt upon the stone.

The paper method is what is called the direct process of photo-lithography, but a plan sometimes adopted is to print the image on zinc and use that to pull the transfers from; the zinc may be either that used for photo-zincography, or thin zinc about the thickness of a Bristol board. In addition to that there are what are called the Hull zinc plates, prepared with a coating which looks like a sort of stone, upon which a print can be made direct by means of bichromated albumen diluted to about one-third the strength of the formula I have already given.

Half-tone with collotype grain is managed in two ways. One way is by coating paper with a thick film of gelatine mixed with various hygroscopic and reticulating substances, such as sulphate of zinc and chloride of sodium, and then sensitising in a solution of bichromate of potash. Unfortunately, however, this process has no degree of certainty about it, and I have found it necessary to fall back upon the collotype grain on a collotype plate, and I pass round one or two transfers done from collotype plates. The method of preparation differs very slightly from that ordinarily adopted in collotype, the only difference being that you add to the gelatine a certain amount of a chemical which has a tendency to harden it, and you put a thicker film of gelatine on the plate. If you tried to get the grain by simply increasing the thickness of gelatine, you would find a difficulty crop up, in that unless your picture was very much over-exposed, you would not be able to etch it or damp it to get the ink to adhere. The grain may be differentiated to suit the subject, as the thicker the film the coarser will be the grain.

The best method that I know of for making half-tone transfers is the method of Pretsch. The formula is given in the next lecture, and if I want a fine grain I use 5 minims of solution per square inch of surface to be covered, for a medium grain I take 6 or 7 minims, and 8 minims per square inch gives a coarse grain; of course the collotype plate must have been previously prepared with beer and silicate, dried and washed, and again dried. The best negative for collotype transfers is a thin one with plenty of detail, such as is recommended for printing in collodio-chloride and some of the newer printing methods; the exposure should be full, and the high lights ought to be just slightly tinted. Then you plunge the plate into a saturated solution of borax at about 90°, rock it for a minute or two, leave it until the solution is quite cold, and then wash under a tap and soak in clean cold water until the whole of the bichromate is removed, which takes about all night. When this is finished the plate must be dried, and if the film is thick this operation may be accelerated by soaking in methylated spirits;

when dry it is etched, and the transfers are pulled in the usual way. Ink up the plate in the ordinary way, and when you have pulled two or three proofs, you pull the transfers on good Scotch paper that is rather old, as new paper is apt to stick to the plate. The process of transferring to stone lies within the province of the lithographer, and the only thing that need be said about it is that the stone must be perfectly polished and free from scratches.

Photo-lithography, too, is now very often done from grain negatives as made for half-tone photo-zincography; but in making negatives through a screen specially for photo-lithography, it is always best to use a stop a shade large, so that you bung up the high lights a little, as you then save a lot of touching up on the stone. This cannot be done if you are making negatives for photo-zincography, for in that case the dots must show everywhere or else there will be trouble with the etcher. For this class of work the transfer paper must be dried on glass so as to get a glazed surface, in order that there may be absolute contact between the negative and the print; the slightest bit of dust will show a black mark.

I will now pass on to photo-zincography. I pass round two negatives which show the character of negative needed for this process, and from which the prints are made on the zinc. When I began we had to polish the plates ourselves, but now that is done for you, and you have only to wash them with a little ammonia to get rid of any grease, and to put them into a mixture of alum and nitric acid until they are grained, which gives them a matt surface. The plate is then coated on a whirler with a mixture of albumen and bichromate,—generally the white of one egg, 10 ounces of water, and one ounce of a saturated solution of bichromate of potash to which has been added a little ammonia. In this case I find that bichromate of ammonia is perhaps preferable to bichromate of potash, simply because here you want to wash away the whole of the soluble colloid. After exposure to light under a negative the zinc is inked up in the same manner as the paper, the ink being afterwards carefully washed away from the whites, leaving the picture on the metal in ink. The plate is then dried and dusted over with finely powdered dragon's blood; when the surplus has been removed the plate is put on a hot plate, which melts the dragon's blood and incorporates it with the ink, giving a good resist. There is very little to be said on the subject of photo-zincography in line, and we pass on to half-tone. Here, I pass round two half-tone negatives made with Levy's screens, and from the negative prints are put on the zinc in various ways. First of all, the albumen method can be used as for line blocks, reinforced with dragon's blood and heated and prepared for etching as before. That method was greatly in vogue until it was displaced by what is now called the fish-glue process, which is easily worked and which gives the best possible results. I pass round three zincs: (1) the zinc as it is developed, the colour being due to aniline dye which is used to enable one to see the picture; (2) the same thing with the image burnt in, *i.e.*, the fish-glue image has been carbonised by heat, and by that means made acid-resisting; and (3) is the plate etched and ready for trimming and mounting.

Fish-glue is not the only thing used for this process; I have lately been experimenting with gum and albumen, and I find that a mixture of a very bad sample of gum, dissolved in water to the consistency of condensed milk, with white of egg, and sensitised with bichromate of potash, enables one to give a very short exposure and wants very little dyeing. It can also be carbonised without taking the ring out of the metal; that is one of the points where the fish-glue process on zinc fails, because it makes the metal so brittle that it absorbs the ink and does not give the results that are looked for from the block, especially when fast printing is in question. I have tried various other colloids; tragacanth can be used, but it is rather brittle stuff, and it is very difficult to get into a filterable solution, so that my experience is that fish-glue and gum are the two best things at present. The proportions vary with the nature of the gum, but the solution must be of about the thickness of the ordinary fish-glue.

There are other methods of making blocks by the bichromate salts; for instance, there is the swelled gelatine process, which is especially useful for reproducing pen and ink drawings more exactly than is possible in zinco, but it will not do in these days

when an order is brought in at five o'clock and the block is expected to be ready by six. The washed-out gelatine process was much used in America a few years ago ; and another method of utilising the bichromate salts in photography is the dusting-on process, which is very useful for making reversed negatives for collotype.

In reply to questions, Mr. Wilkinson said he recommended Australian gum for use with albumen ; it was very bad for sticking, but answered excellently for the purpose referred to. He could not compare prints from collotype transfers with direct collotype prints, as the former were simply intended to facilitate cheap and rapid reproduction. He thought the fish-glue process, either on zinc or copper, gave a better rendering of the fine half-tone in a photograph than any other method of printing from zinc that he knew of ; a good formula was as follows :—

Fish-glue	...	...	...	...	...	2 ounces.
Water	...	...	...	...	...	2 "
White of egg	...	...	...	...	...	1 "
Bichromate of ammonium	...	...	...	...	...	60 grains.
Chromic acid	...	...	...	...	...	10 "
Liquid ammonia	...	...	...	...	...	$\frac{1}{4}$ ounce.

This should be mixed in the order given. The addition of alum to the graining solution caused a finer grain than would be produced by the nitric acid alone.

A vote of thanks was accorded to Mr. Wilkinson.

VI.

PROCESS APPLICATIONS OF THE BICHROMATE SALTS.

By W. T. WILKINSON.

Friday, May 8th, 1896. Mr. W. Thomas, in the Chair.

IN negative making the salts of silver reign supreme, but in process work the bichromate salts are king, *i.e.*, so far as getting the image upon the metal is concerned, or in fact, in preparing any kind of a photo-mechanical printing surface. The bichromate salts most used and most useful are those of potassium and of ammonium, the bichromate of soda has been advocated, but it is of such a hygroscopic nature, that it is more or less a failure when used to sensitise any of the colloid bodies, which in themselves are far too susceptible to what may be termed the most serious trouble met with in working a colloid body, *viz.*, damp, therefore to use as a sensitiser a substance that is deliquescent is to court failure, and it usually comes ; in no method can sodium bichromate be used with anything approaching practical success.

The potassium salt is the one most universally used, especially for collotype and photo-lithography, in fact in any process where gelatine forms the ink bearing surface and where it is not required to dissolve away those parts not acted upon by light.

The ammonium salt is best when used with colloids which are soluble in cold water, and which have to be dissolved away to form the whites as in photo-zincography.

The reason of this difference is because when the potassium salt is used, spontaneous insolubility commences as soon as the gelatine is dry, and this is an advantage in collotype and in photo-litho, but not when using the soluble colloids necessary for photo-zincography for which albumen, gum tragacanth, gum senegal, fish-glue, &c., are used, the ammonia salt allows more time to elapse between sensitising and development, it not being so susceptible to damp, consequently is not so liable to cause insolubility without light action like the potassium salt. To ensure success in all processes where bichromate salts are used (especially potassium) great

care must be taken to avoid damp; this is one of the reasons why collotype has such a name for uncertainty, a little insolubility in a collotype film is of no moment, so long as the power of absorbing water is not restricted, as directly that point is reached, then trouble begins, the ink adhering to the whites as well as the darks, this process depending so much upon the discriminating power of absorbing water in sufficient quantity to give half-tones as well as lights, which is destroyed when the action of moisture is allowed to set up spontaneous insolubility.

Photo-mechanical methods may be classified into three groups, the first of which is photo-lithography; in this there are two branches, viz., line and half-tone, the function of photography being to produce a print or transfer by the aid of which the lithographer prepares the printing surface. In collotype the photographer produces the actual printing surface, from which the prints are made in a very similar manner to which lithographic prints are produced.

The second group embraces relief blocks for printing with type in line or in tone, the photographer producing the image on either copper or zinc, leaving the etcher to bite into relief, these methods are called zincography, but there are other methods of producing type blocks by the aid of light, viz., the swelled gelatine and the washed-out method in which a gelatine relief is made, from which plaster casts can be made, and from these blocks by electrotyping.

The third group is that of the intaglio methods, known better as photogravure, here the bichromate salts are put to use in every method, the rival processes varying in detail in the method of obtaining the grain, *i.e.*, the power of holding the printing ink, in due gradation to form the picture.

The first and second of these groups were treated of last week, but it will perhaps be useful to recapitulate a little and give a few points as to failures and their remedies. In photo-litho in line a perfect transfer must be as follows, the lines must be perfectly firm and free from rottenness, the ink forming the image must be hard and free from any tendency to spread, and as little as possible should be used, the whites must be quite clean, the gelatine coating must be quite insoluble, but its absorbent qualities must not be interfered with, it must retain unimpaired its adhesiveness, else the transfer will slur when the attempt is made to transfer the ink image to the lithographic stone.

For photo-litho transfers in half-tone the smooth gradations of the photograph must be broken up by the discriminating reticulation of gelatine, prepared in a special manner for this purpose; there is no process yielding such uniform results as the process of Pretsch, and of which I will here interpolate the formula and its method of compounding.

First of all the gelatine is a very important item, it must be of a very soft variety as may be understood when the maximum of reticulation is required. I generally use Kreutz's soft, and mix it with a little fish-glue in order to accentuate the grain.

No. 1.

Kreutz's soft gelatine	...	...	...	...	50 grammes.
Clarified fish-glue	...	...	...	...	15 "
Water, 7 drams	...	...	...	...	200 c.c.

Soak the gelatine in the cold water till it is perfectly soft, then melt, add the fish-glue, and stir until it is also dissolved. *Note.*—Be sure and do not raise the temperature of water in pan over 55° C. (130° F.)

Now prepare the following:—

No. 2.

Ammonium bichromate	...	...	...	...	4 grammes.
Water	...	...	...	...	100 c.c.

No. 3.

Silver nitrate	...	...	...	...	2 grammes.
Water	...	...	...	...	100 c.c.

No. 4.

Calcium chloride (crystals)	...	...	...	1 gramme.
Water	...	...	...	20 c.c.

To No. 1 add No. 2, using a stirring rod vigorously, next add No. 3 stirring vigorously all the time; the mixture will now be of a red colour from the chromate of silver,—now add sufficient of No. 4 to just discharge the red colour and turn the mixture white, now stir in 8 drops of acetic acid, then 10 of glycerine, strain through muslin, and coat collotype plates which have been previously coated with substratum of beer and silicate, and warmed in the collotype oven, putting on the plate not more than 6 minims of the above for each square inch of surface to be coated, dry at a temperature not exceeding 55°C . (130°F .)

When dry expose to light under a reversed negative until all details can be seen on back of plate, then plunge into a warm saturated solution of borax, then wash in clean cold water for 3 or 4 hours, then dry, when dry etch up and print from in the same way as from an ordinary collotype plate, using transfer ink mixed with collotype printing ink, and pulling the transfers upon a good Scotch transfer paper which has been well rolled, and which is a little hard from age, these transfers are put down upon extra smooth stones in the ordinary way.

Passing onwards to photo-zincography for printing on the metal, there is nothing so satisfactory as the bichromated albumen, the ammonium salt being preferred as sensitiser, for half-tone the same can be and is very largely used, but the best is either fish-glue or gum senegal and albumen, the image being subsequently carbonised in order to confer acid resisting powers.

Collotype has got at present a bad name, but to my thinking there is no justification for it, because, if the process be worked carefully and intelligently, it is quite as certain as any other photographic method in which a colloid is used. First of all the plate must be clean and the substratum perfect, good beer and soluble silicate used with careful and thorough rinsing after drying, the oven must be well ventilated so that the sensitive film is dried not baked, the gelatine used must be hard, and if not hard enough should be hardened by the addition of spirits of wine, the bichromate used must be potassium, as this sensitiser does not solarise, consequently the shadows are amenable to the etcher, the quantity of gelatine mixture put on the plate must not exceed 5 minims per square inch, taking the average strength of gelatine mixture at 50 grains per ounce of water, and finally the greatest precautions must be taken to guard against damp touching the film between drying and washing-out the bichromate.

Collotype in England is not so good as it ought to be because the photographic part of the work is starved, unskilled men are put to do difficult work, and unsuitable premises are used, and the consequence is that the work produced is so bad that the process is discarded as impracticable. It is sometimes said, too, that collotype is not suitable for three-colour work, but this is not my experience, and the prints which I pass round will show I think that it is very well adapted for three-colour work.

The third group, comprising photo-gravure, like all the rest has many modifications, which is not to be wondered at when it is remembered that it dates from 1852.

FOX TALBOT'S PHOTO-ENGRAVING PROCESS.

This method was patented in 1852, and consisted in coating a steel plate with bichromated gelatine, when dry this is exposed to light under a transparency, after exposure the plate is soaked in a mixture of sulphuric acid and vinegar, in this those parts of the gelatine not acted upon by light are washed away leaving a half-tone negative upon the metal, the plate is etched in a solution of platinum bichloride.

At the same time Mr. Fox Talbot patented the first method of obtaining a grain for obtaining half-tones; this was by first exposing the film of bichromated gelatine to light under a piece of gauze, following this by exposure under a half-tone negative.

In 1858 Talbot patented the use of powdered resin for the production of a grain, this was done by dusting over a film of bichromated gelatine, after exposure

to light under a half-tone negative, with powdered resin, this resin being afterwards melted, the etching being done with perchloride of iron.

The modern methods of photogravure differ from this in having the ground put on before the sensitive gelatine, or in the case of the Klic method, of the exposed film of carbon tissue.

En passant for photogravure the finest results are obtained by first coating the metal with a solution of fish-glue, bichromated fish-glue, drying, then exposing to light under a ruled screen of from 200 to 300 lines to the inch, single ruling only; after exposure to light under the film is developed in cold water coloured with aniline, washed, dried, and burnt in; on this ground either a carbon negative print is mounted and developed or a thin film of gelatine is used, say:—

Soft gelatine	...	...	...	...	30 grains.
Water	...	...	...	...	1 ounce.
Potass. bichrom.	...	...	...	...	7½ grains.

This should be spread on a whirler, drying face up, over a spirit lamp.

I find after many careful experiments that gelatine will on an average take 25 per cent. of its own weight of bichromate of potash without its crystallising out, and of ammonium bichromate about 50 per cent.

Another method of photogravure is by dusting a Woodbury relief with powdered glass, or incorporating it or some such substance; with the bichromated gelatine when dry, after development, a cast is taken, and from that an electro made.

Another method is that of Waterhouse, in which a Woodbury relief or a print in carbon, developed on a copper plate, is dusted over with fine sand previously waxed; this sand produces pits in the film, the film being dried, the sand is dusted off, and a grained image remains from which a copper printing plate is produced by electrolysis.

Mr. Foxlee patented a process in which powdered resin was dusted over the gelatinous image, and when dry this resin was dissolved out by a suitable solvent.

In Mr. Sawyer's process plumbago in powder was introduced into a carbon tissue, which was sensitised in bichromate, and after development the print was used for electrotyping from.

From the foregoing it will be seen that in every one of the practical, and even the non-practical, photo process methods the bichromate salts are the most useful salts we have, and their usefulness extends into the domains of the silver salts, and gives us the only really permanent solar printing process, viz., the Woodbury type process, even the carbon process to many people is more dependable in its permanency than the platinum process, and certainly beats it in variety of result and in ease of working.

At present the one drawback to the bichromate salts lies in the spontaneous action which is so similar in its action to that of actinic light; if that fault could be overcome or minimised those salts would be perfect as sensitisers.

I am now able to show you a new application of photography in connection with the bichromate salts, in the production of rollers for calico printing, and embossing velvets, and wall papers, &c. I pass round for inspection a portion of a roller such as is ordinarily used for the work, with the pattern in intaglio, and also specimens of calico and velvet, printed and embossed by means of rollers produced by a photographic method, photo-lithographic transfers being transferred to the roller, and then etched, the ink acting as a resist. I have been engaged on this process for the past two years, and this is the first time it has been publicly referred to; rollers can be produced by it very much quicker and cheaper than by the usual method.

In conclusion, I would say that no matter how perfect the bichromate methods may be, nor how easy and simple to work, that no success can be attained unless the negative is suitable, each method treated of in this series of lectures requires its own particular negative, and whether our dear old friend wet collodion or the newer love gelatine be used, make the negative for the process, do not try and make the process fit the negative.

A vote of thanks was passed to Mr. Wilkinson.